Defense Logistics Agency Standardization Conference

Developing More Cost Effective Batteries

Dale Roberts

Sustainment Engineering Branch
Defense Supply Center Richmond
Defense Logistics Agency
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DLA Sustainment Engineering

Reliability Initiative

...THE BEST IN WEAPON SYSTEMS SUPPORT

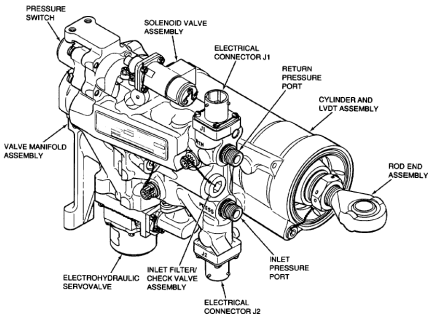
Reduce Total Operating Costs

Support the War Fighter

Improve Parts Availability

Integrate Technology Solutions Across Services

Improve Reliability



Hybrid Battery Supercapacitor

- Air 4.4.4.1 has prototype in testing
- Technical challenges.

Supercapacitor Benefits

- Long life. Should outlast airframe
- No maintenance
- Performance over wide temperature range
- No hazardous materials
- Reduces battery requirements and disposals
- Fast recharge

AH-1 Test Table

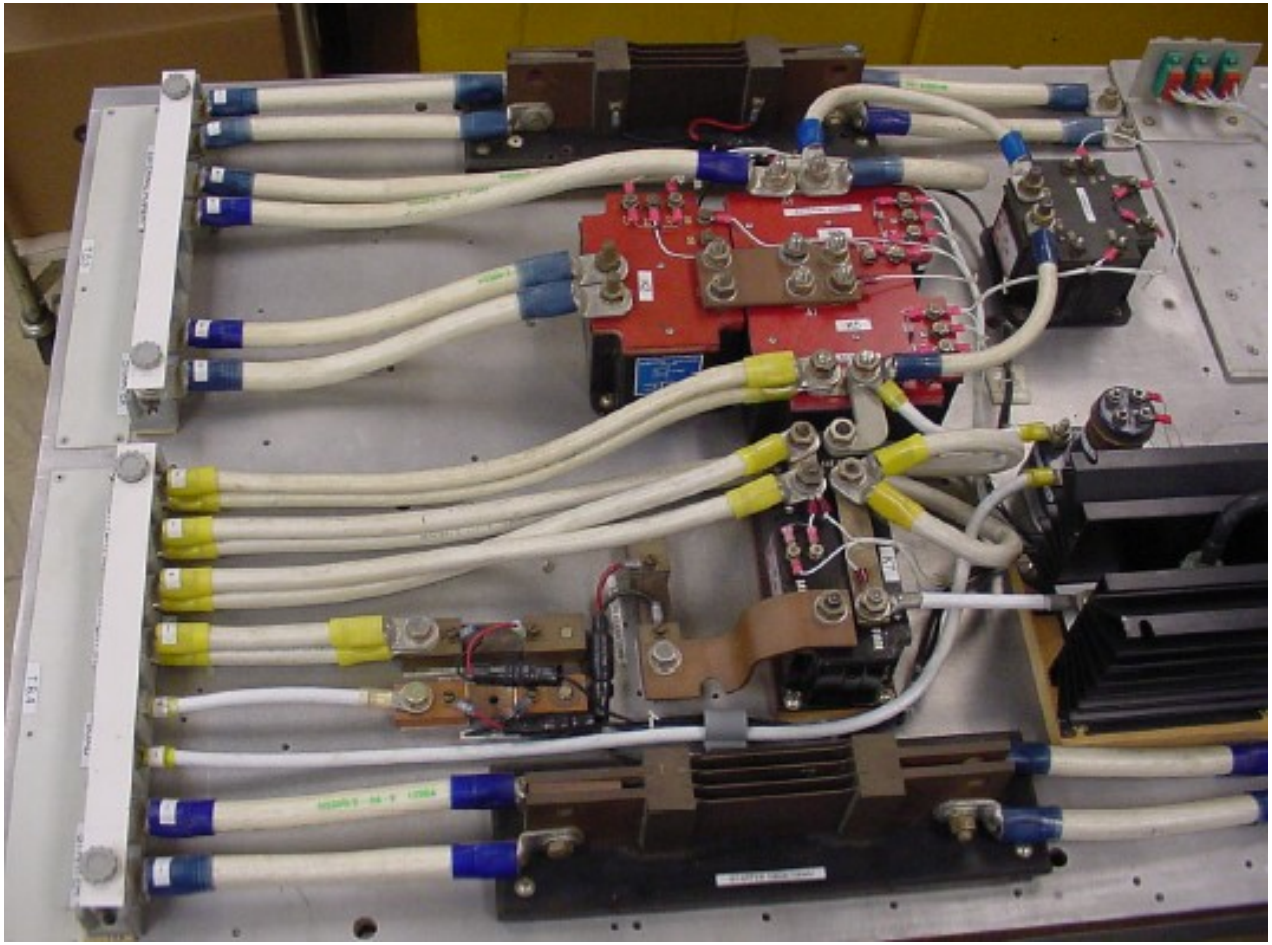


Photo provided by Bill Johnson, Air 4.4.4.1.

Close-up of Bus Transfer Relay (K7)

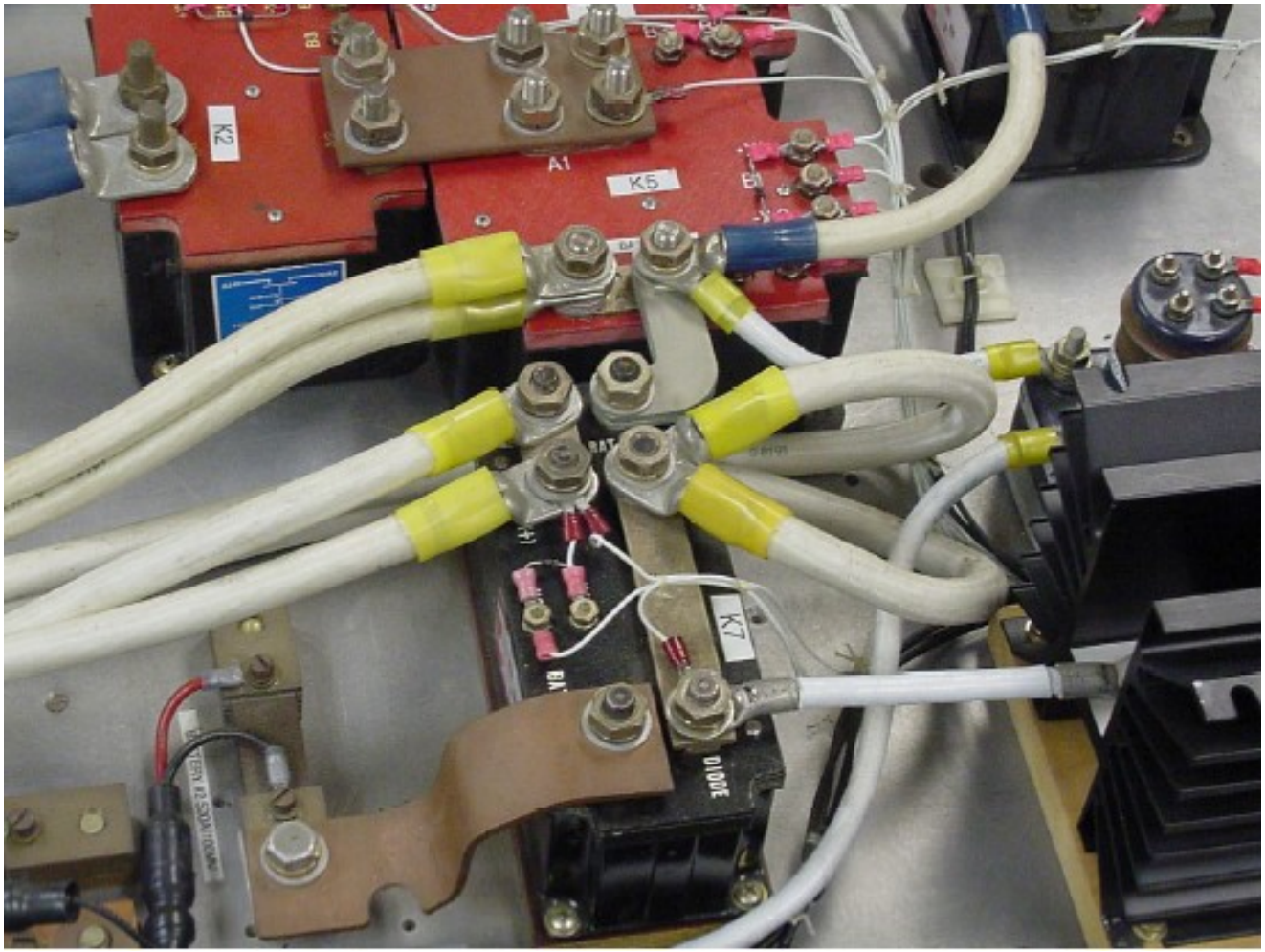


Photo provided by Bill Johnson, Air 4.4.4.1.

Power Supply and 48 kW Electrical Load

Provided by Bill Johnson, Air 4.4.4.1.

Photo provided by Bill Johnson, Air 4.4.4.1.

Test Items

2 D8565/10-1's (blue)

1 Lead-Acid Battery (red top)

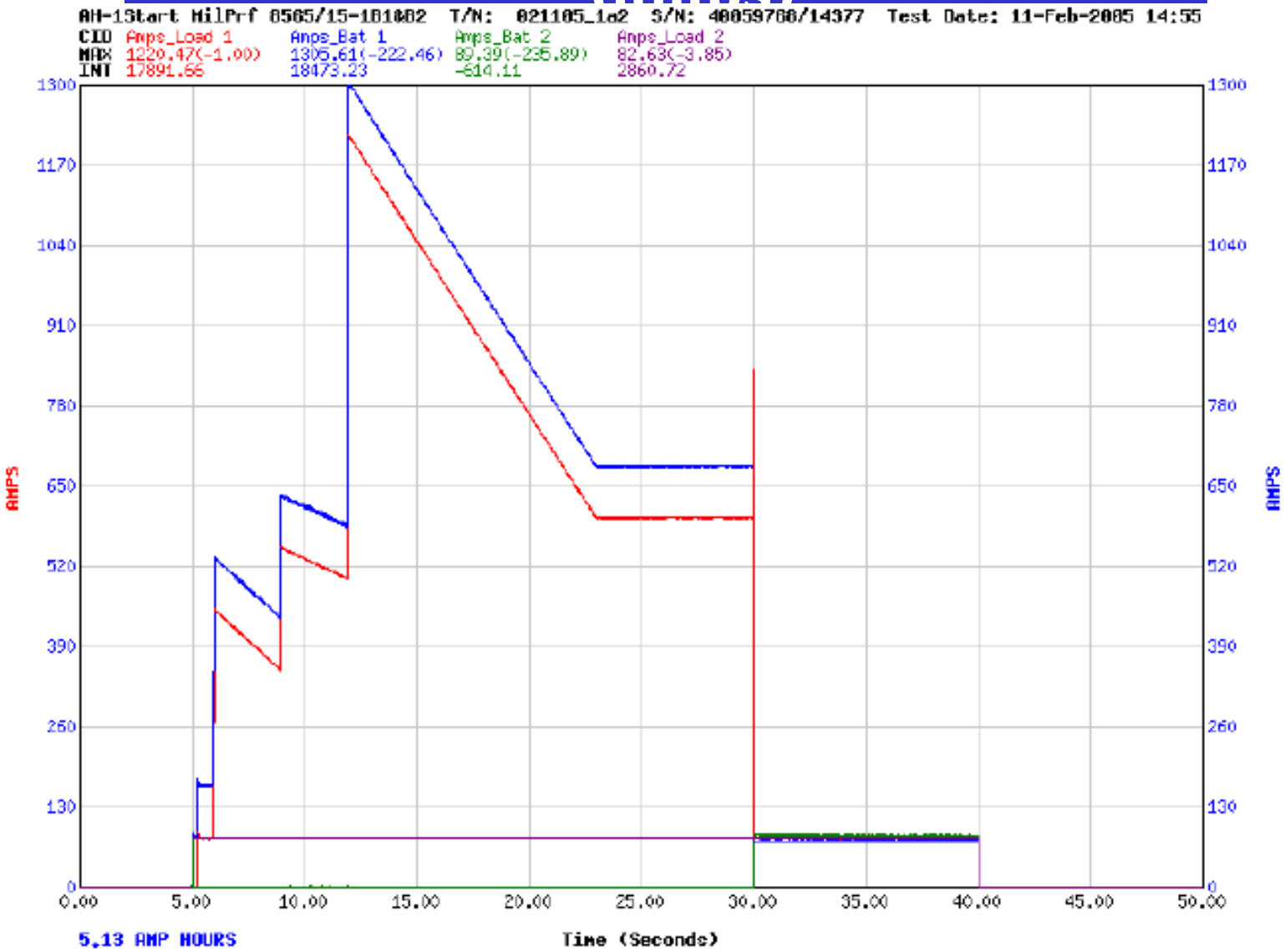
1 Supercapacitor (black top)

Photo provided by Bill Johnson, Air 4.4.4.1.

Data Acquisition Systen

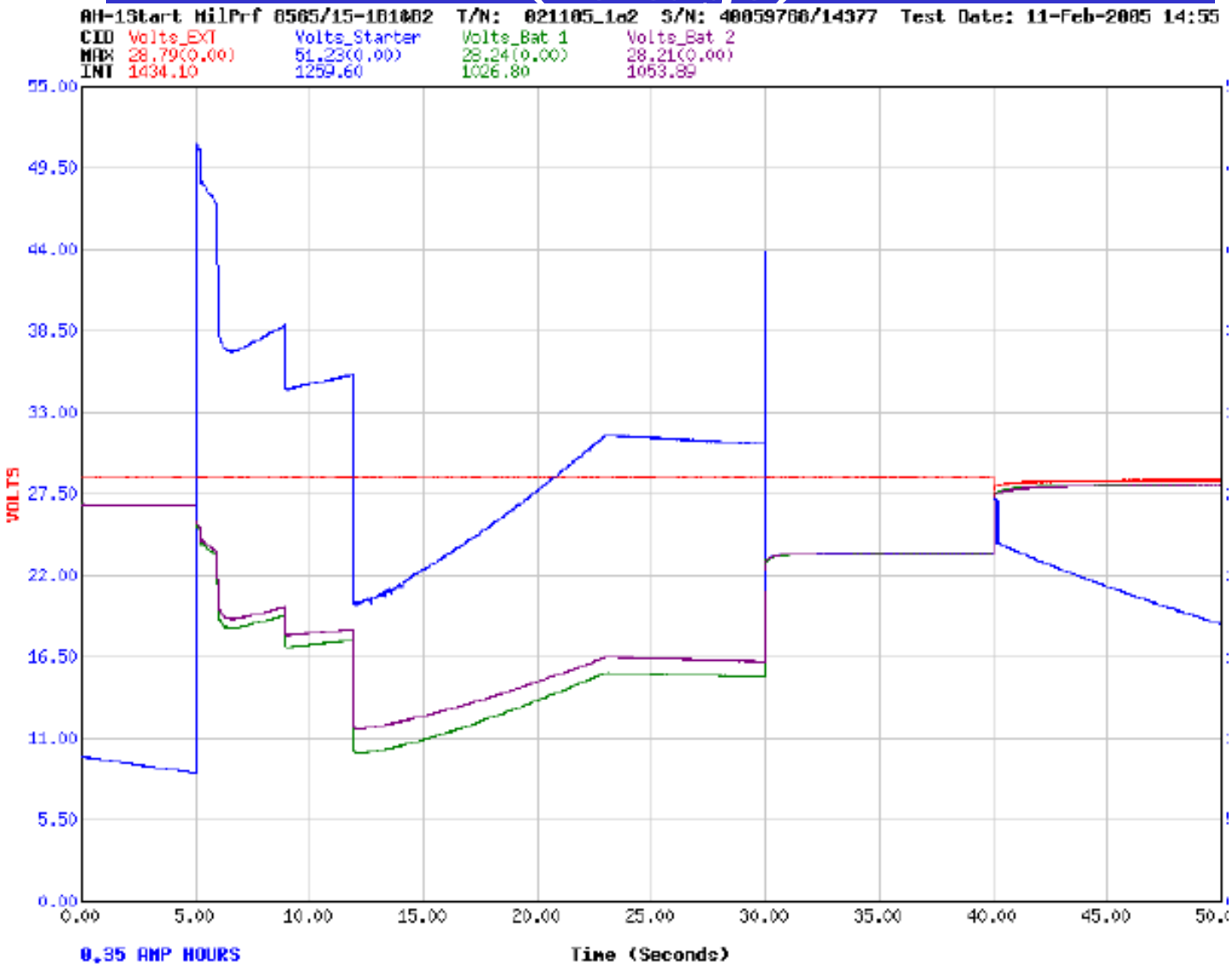
Photo provided by Bill Johnson, Air 4.4.4.1.

(2) D8565/15-1 with No Supercapacitor (amps)



Provided by Bill Johnson, Air 4.4.4.1.

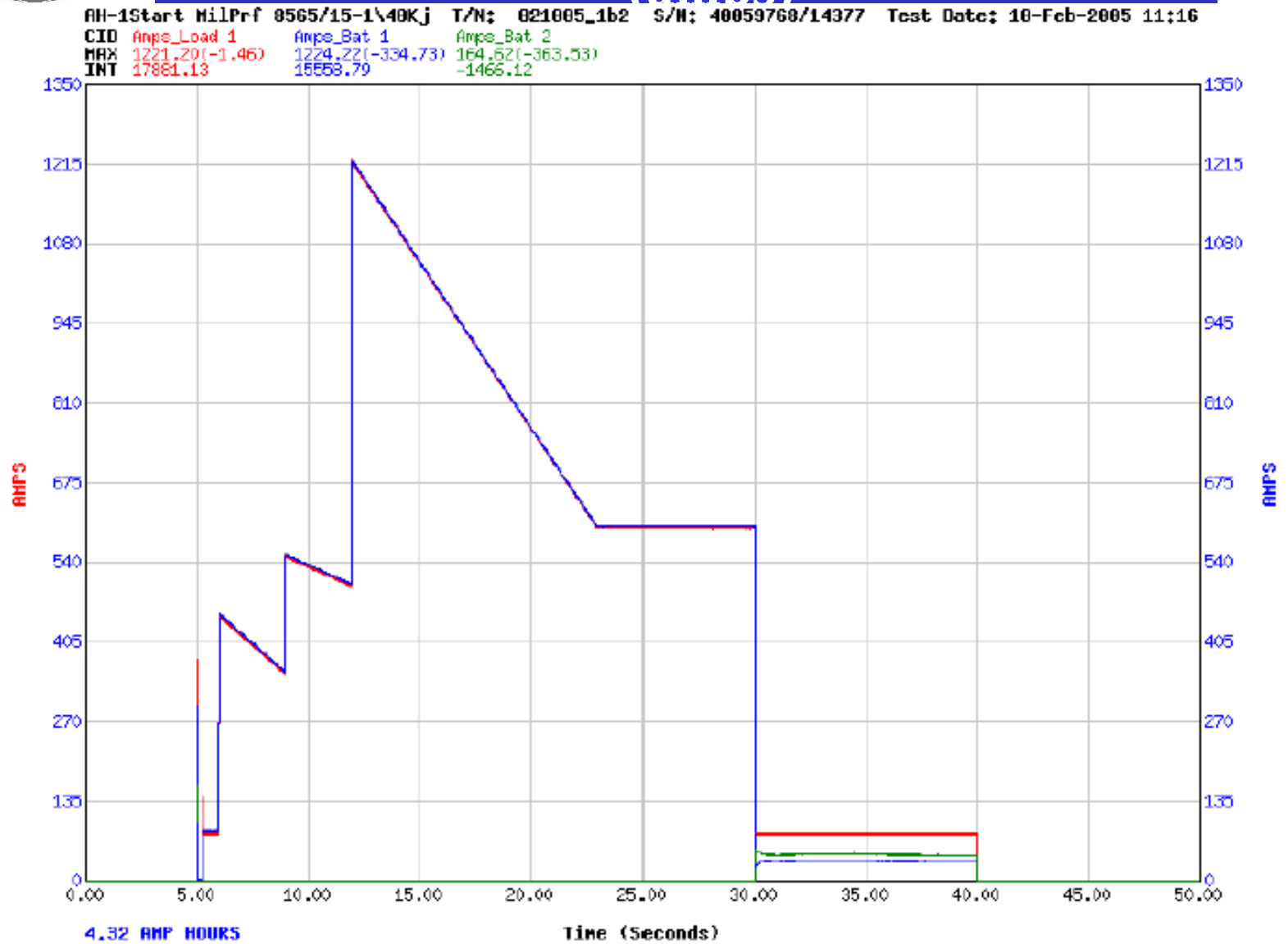
(2) D8565/15-1 with No Supercapacitor (voltage)



Provided by Bill Johnson, Air 4.4.4.1.

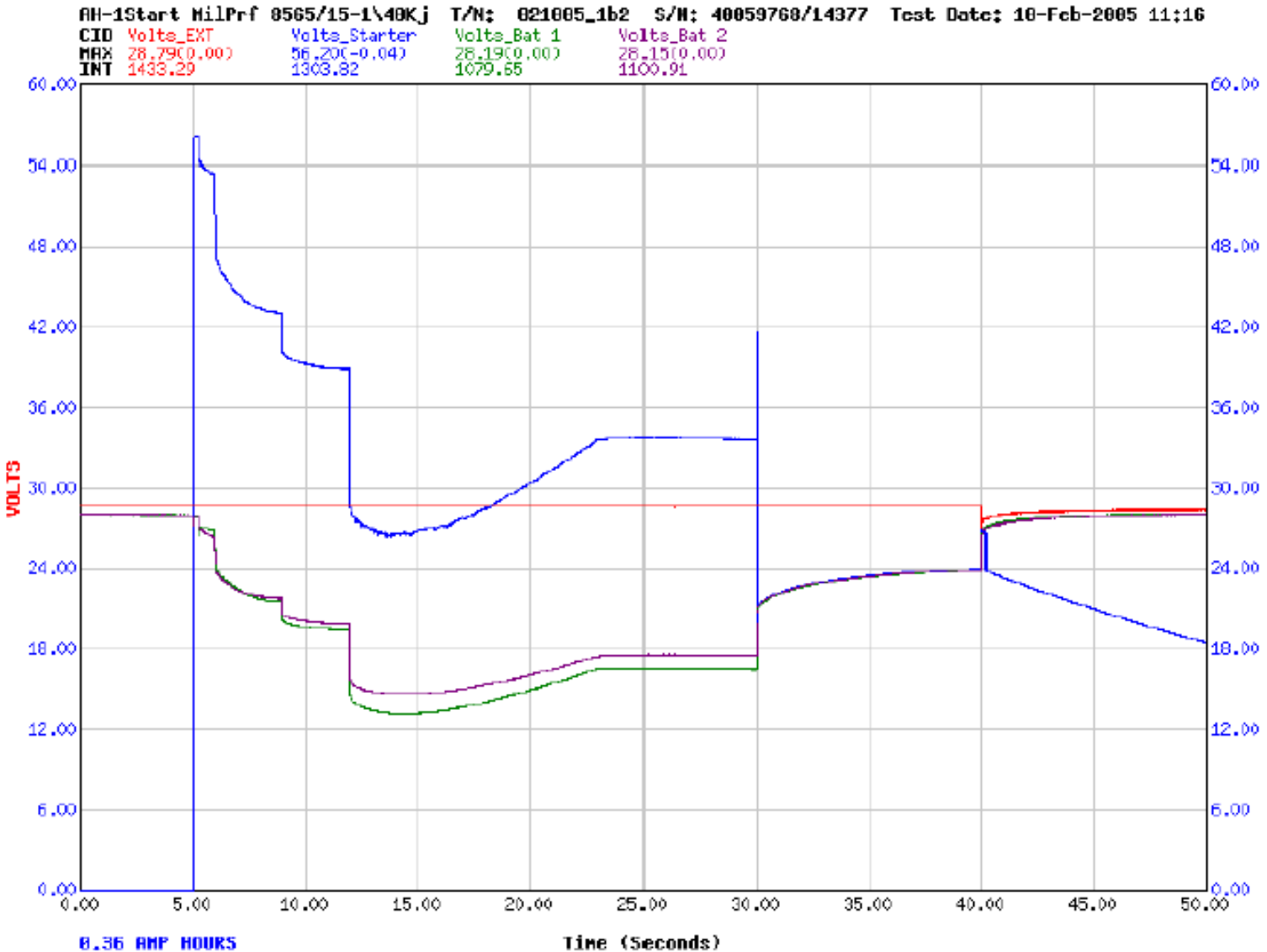
(2) D8565/15-1 with 40 Kj Supercapacitors

(amps)



Provided by Bill Johnson, Air 4.4.4.1.

(2) D8565/15-1 with 40 Kj Supercapacitors (voltage)



Provided by Bill Johnson, Air 4.4.4.1.

Supercapacitor Availability

- Supercapacitors used in testing are available for additional applications
  - PN 700010 (53203) NSN 6140-01-503-6137 120KJ
  - PN 700014 (53203) NSN 6140-01-504-4757 40KJ
- DLA can support you via the Reliability Initiative, to explore development efforts involving supercapacitors.
- Contact us: Sustainment Engineering Branch
  - Dale Roberts, Navy Team, Engineer, at 804-279-3866
  - Edilia Correa, Branch Chief, at 804-279-6233

NiCad to Lead-Acid Battery Conversion

- Lower cost
- Low maintenance
- May eliminate need for charger
- Better performance than older des
- Evaluate on a case-by-case basis

Shelf Life Testing

- Batteries often have short shelf-lif
- Shelf life is not always consistent
- Cells may be common to batteries
- Extension may be possible

Separator for NiCad

- NiCad performance declined
- Evaluation of problem needed
- Acceptable materials identified

E-3 Battery Project

- High cell usage
- New low maintenance battery
- Charger upgrade
- Thermal monitoring issues
- Navy experience with mixing cells
- Whole battery replacement

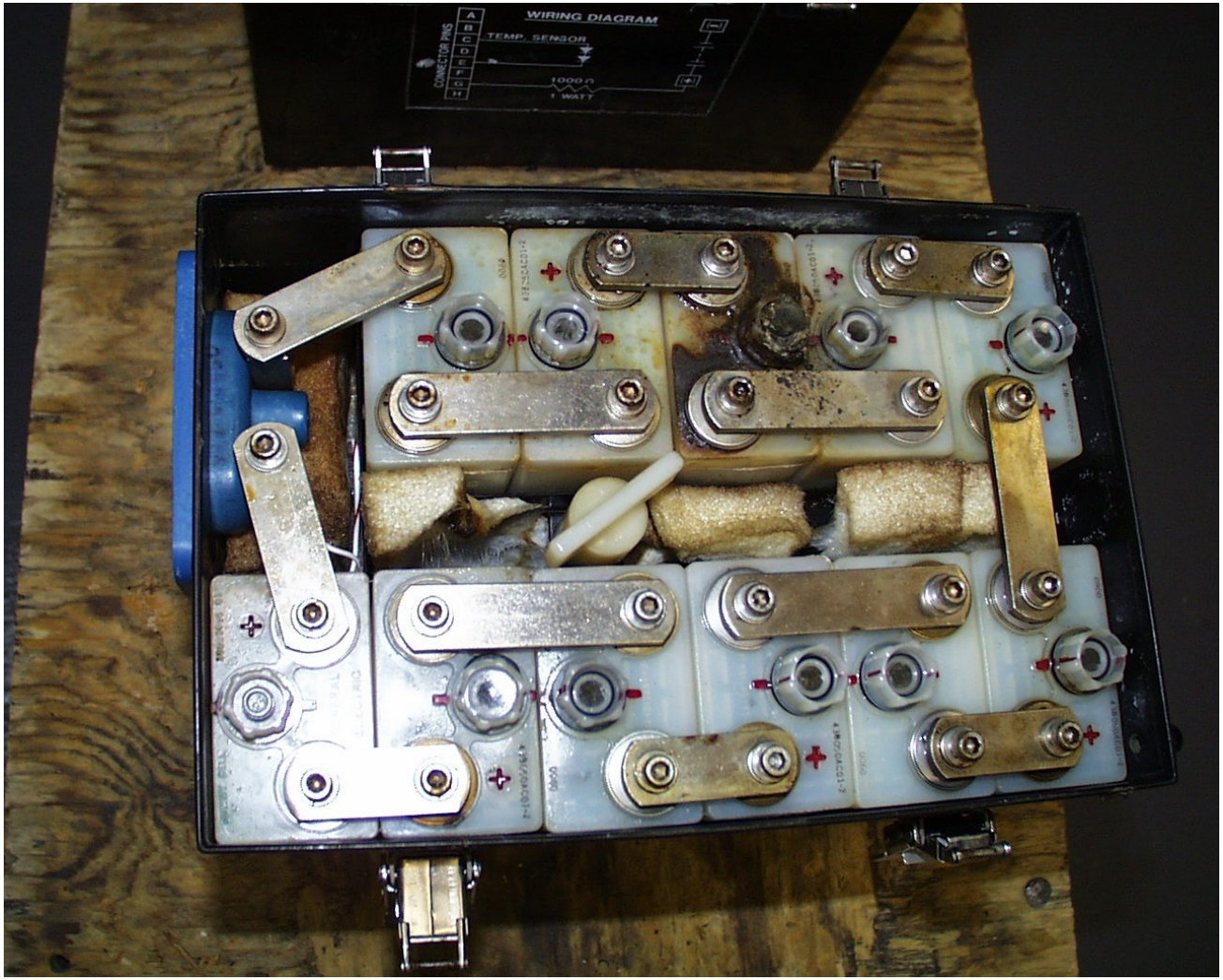
Variation in NiCad Cells Reduces Life and Performance

"…. some …. cells age at different rates …. they gradually develop different charge capacities, and as the battery as a whole is charged and discharged repeatedly, these differences are accentuated - a kind of 'survival of the fittest' process occurs."

"…. result is …. 'weak' cells can be discharged well **below the 1.1 (Volt) level**, and even driven into **reverse charge**, before the others reach the fully discharged state. Then during recharging, the same cells tend to **absorb most of the charge** and **overheat**, while the others (…. not properly discharged) are improperly recharged and tend to **suffer increased crystal growth**."

Excerpts from: Electus Distribution Reference Data Sheet: USING & CHARGING NI-CAD BATTERIES (2001)

NiCad Battery With Failed Cells



NiCad Cell Failures

NiCad Temperature Increase and Voltage Decrease in Overcharge

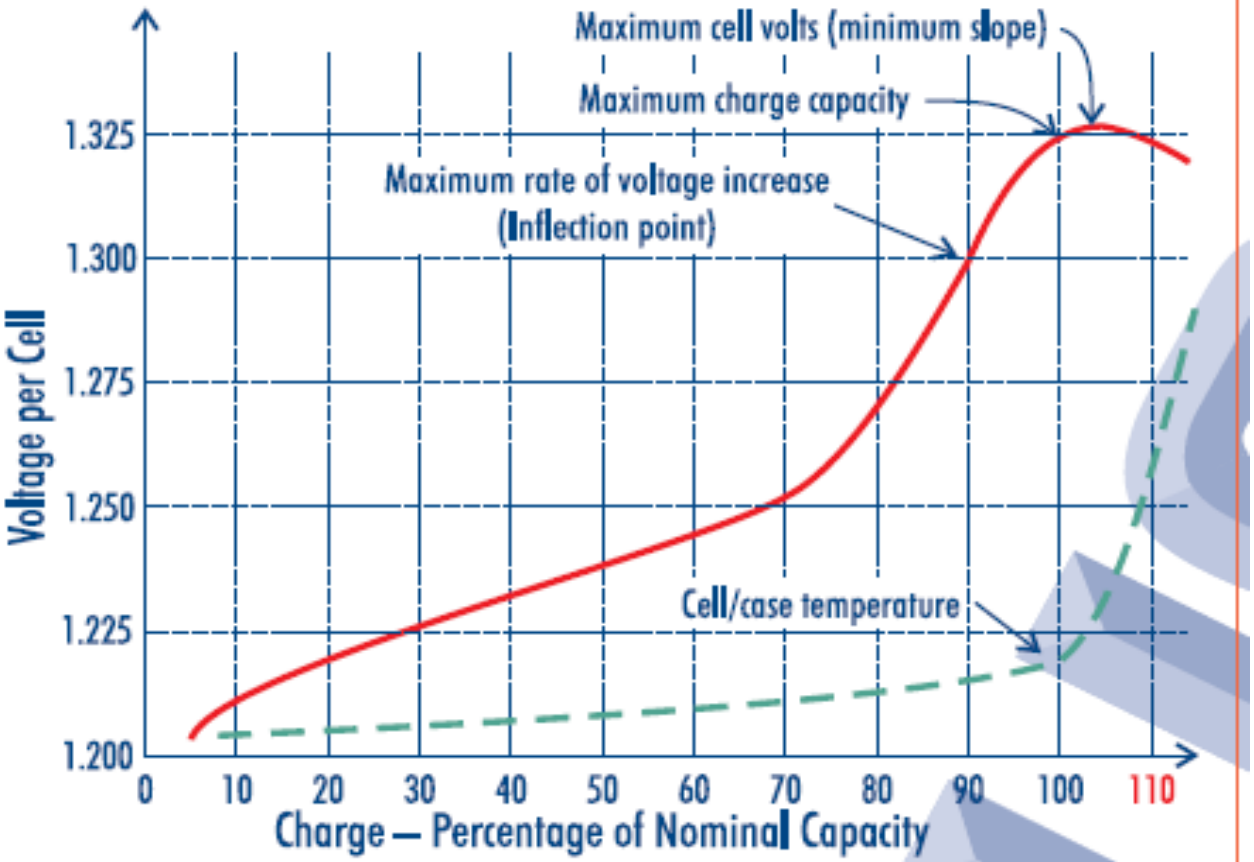
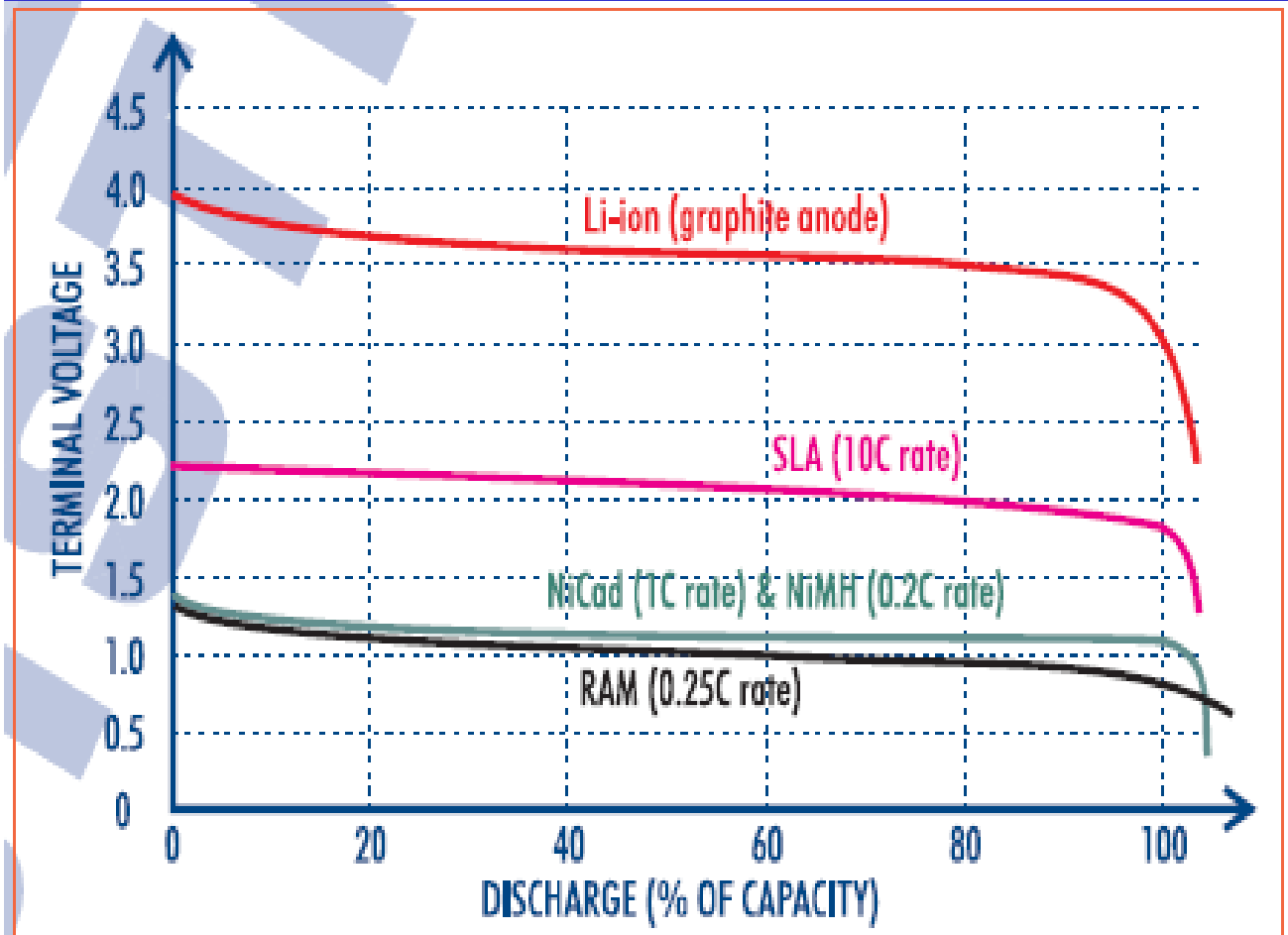


Fig. 2: How the terminal voltage of a typical NiCad cell (and also its temperature) tends to vary during charging. Both the inflection point and the voltage peak are used for end-of-charge detection in high-end chargers.

Reference: Electus Distribution Reference Data Sheet: NICAD.PDF (1)
USING & CHARGING NI-CAD BATTERIES (2001)
www1.electusdistribution.com.au/notes.asp

NiCad Voltage Drop at 1.1 Volts



Discharge curves for one cell of each of the five main types of rechargeable battery, compared at typical discharge rates.

Reference: Electus Distribution Reference Data Sheet: RECHARGEABLE BATTERY (2001)
Title: CHOOSING A RECHARGEABLE BATTERY (2001)
www1.electusdistribution.com.au/notes.asp

Audits on Aviation Battery Manufacturers

- Supplier changed separator and wett
- Changes reduced NiCad performanc
- Other changes may have negative im
- Goals:
  - Identify changes
  - Evaluate impact
  - Increase performance

NiCad Deletion List

Part Number	Cost	#/yr	$/yr
• M81757/9-3	$1,590.79	36	$ 47,724
• M81757/9-2	$1,547.72	20	$ 37,145
• M81757/11-3	$1,441.23	24	$ 36,031
• M81757/12-2	$2,627.79	16	

Connector Standardization MIL-PRF-8565

- D8565/5-1 & /5-2 are identical, except for connector
- Testing connectors
- ECP will be generated

Standardize Batteries D8565/7-1 and -2

- Battery has -1 and -2 configuration
- AV-8 and AV-8B only -1 user
- Standardizing to -2 requires:
  - ECP (engineering change propos
  - Manual changes
- Upgrade is being implemented

Evaluate C-5 Failed NiCad Cells

- 41 failed cells evaluated
- Compared with 25 cells from stock
- Burns at top and water loss
- Large spread in age
- Root cause analysis indicates mixed cells are

Crane Shelf Life Activities

- Some lead-acid batteries have 6-month or less shelf-life
- Evaluating options for extension:
  - Shelf-life data
  - Shelf-life testing
  - Environment and procedures

Battery Standardization

- Reviewing part numbered batteries
- Switch from FAT to QPL
- Improve availability
- Can improve quality

Standardization Funding Issue and Resulting Exceptions

- Example exceptions to MIL-B-8565/10 F
- Numerous exceptions affect procureme

Procurement Item Description (S9G)BATTERY, STORAGE NICKEL CADMIUM, WET QPL APPLIES SHIPPING NAME: BATTERY, WET, FILLED WITH ALKALI,UN ID SPECIAL INSTRUCTIONS FOR NSN: 6140-01-459-7962- P/N 023686-000, 6140-01-429-2629-P/N 08565/10-1 SOLICITATION NOTES:

NOTE: TESTING OF THE BATTERY SHALL BE IN ACCORDANCE WITH MIL-B-8565/10AS TABLE 1 WITH THE EXCEPTION OF THE FOLLOWING:

2 VENITING 3 DIMENSIONS AND WEIGHT 5 CONTAINER BODY TO CONTAINER COVER SEAL 6 STRENGTH OF HANDLES 8 STRENGTH OF RECEPTACLES 12 DISCHARGE WHILE INVERTED 15 ALTITUDE 18 VIBRATION THE FOLLOWING CHANGES SHALL APPLY:

A. FIGURE 1: CHANGE THE BATTERY FROM 13.84 INCH TO 14.55 INCH MAXIMUM.

B. FIGURE 1: DELETE THE 2.90 INCH HANDLE LOCATION DIMENSION.

C. FIGURE 1: CHANGE THE DIMENSION OF THE DISTANCE BETWEEN THE LATCHES FROM 9.40 * 0.60 TO9.80 * 0.06 INCHES.

D. FIGURE 1: CHANGE THE DIMENSION OF THE DISTANCE BETWEEN THE BATTERY CENTER LINE AND THELATCH CENTER LINE FROM 4.6 * 0.20 INCHES TO 4.90 * 0.06 INCHES.

E. FIGURES 5: CHANGE THE VOLTAGE PROFILE TO REVISED PROFILE (FROM MOD OF PERVIOUS CONTRACT) HAVING DISCRETE STEPS OF 19.5V, 18.5V, 13V, AND 17.0V.

F. FIGURE 7: CHANGE THE VALUES OF THE POWER SPECTRAL DENSITY FORM 0.1060 TO 0.040 AND 0.0106TO 0.020.

G. REQUIREMENT 5: CHANGE THE MAXIMUM WEIGHT OF THE BATTERY FROM 85 POUNDS TO 86 POUNDS.

H. REQUIREMENT 9: ADD THE FOLLOWING REQUIREMENT:THE MINIMUM DISTANCE BETWEEN THE LOWEST PART OF THE HANDLE AND THE BOTTOM OF THE BATTERY CASE SHALL BE GREATER THAN 1.5 INCHES.

I. REQUIREMENT 11.B.: AFTER THE CONNECTING LEAD WIRES CAN BE NICKEL PLATED, ADD OR SILVER PLATED.

J. REQUIREMENT 11.D.: CHANGE AD590L TO AD590M.

K. 3.6.3.1 COLOR: DELETE NARRATIVE AND REPLACE WITH: THE BATTERY SHALL BE IDENTIFIED AS AN ALKALINE BATTERY BY APPLYING A COLOR IN ACCORDANCE WITH TABLE 1 TO THE CONTAINER COVER AND AS THE BACKGROUND OF ALL BATTERY LABELS.

L. 3.6.8 CAPACITY AND ELECTRICAL PERFORMANCE:

CHANGE -30C TO -26C.

M. 3.6.17 HUMIDITY: CHANGE 54 MINUTES TO 50 MINUTES.

N. 3.6.23 PROFILE DISCHARGE AT -18C: CHANGE FOREACH PROFILE DISCHARGE TO TWO OF THE THREE PROFILE DISCHARGES.

O. 3.6.26B: CHANGE 5 PERCENT TO 5 DEGREES FAHRENHEIT.

P. 4.6.15 CHARGE AND DISCHARGE AT LOW TEMPERATURE: DELETE C. DISCHARGE BATTERY AT 30 AMPERES FOR 30 MINUTES.

Q. 4.6.15 CHARGE AND DISCHARGE AT LOW TEMPERATURE: DELETE D. CHARGE BATTERY AT 28.25 VOLTS FOR A PERIOD OF 2 HOURS.

R. 4.6.15 CHARGE AND DISCHARGE AT LOW TEMPERATURE: DELETE E. REST THE BATTERY ON OPEN CIRCUIT IN A 18C TEMPERATURE CHAMBER FOR 24 HOURS.

S. 4.6.21 TEMPERATURE RISE AND FLOAT: DELETE ENTIRE TEST IN SPECIFICATION SHEET AND USE THE TEST IN THE BASE SPECIFICATION.

T. 4.6.23 VIBRATION: DELETE THE TEXT OF E. AND SUBSTITUTE DURING VIBRATION, DISCHARGE THE BATTERY AT 3.5 AMPERES.

U. 4.6.23 VIBRATION: IN H. DELETE 3.6.11 AND SUBSTITUTE THE 14-VOLT DISCHARGE OF 4.6.11C.

THE APPLICABLE NSNS AND PART NUMBERS ARE AS FOLLOWS:

6140-01-459-7962 P/N 023686 -000 6140-01-429-2629-P/N 08565/10-1 ...END OF SPECIAL INSTRUCTIONS...

EXCEPTION TO TABLE 03302: LINES 078 AND 079 DO NOT APPLY TO THIS ITEM DESCRIPTION.

EXCEPTION DATA: GOVERNMENT WILL PAY FOR TEST SAMPLES REQUIRED BY PARA,4.4 OF MIL-B-8565J AD590L OR AD590M ACCEPTABLE TECHNICAL DATA PACKAGE AVAILABILITY THIS NSN IS PROCURED AS FULLY COMPETITIVE IN ACCORDANCE WITH A MILITARY/FEDERAL SPECIFICATIONS/STANDARDS AND/OR VOLUNTARY INDUSTRY) STANDARDS. REFER TO SECTION L, CLAUSE52.211-9G13 FOR OBTAINING SUCH DATA.

EXCEPTION DATA TO PARA,4.3.1.1 CONTRACTOR MAY REQUEST LARGER LOT SIZES WITH AN APPROVED CONTINUOUS PROCESS INSPECTION PLAN APPROVED BY THE PROCURING ACTIVITY AND THE ESA.

EXCEPTION DATA: NO CONTRACT LOTS SHALL BE RELEASED FOR SHIPMENT UNTIL LOT ACCEPTANCE TESTING IS MET AND FINAL APPROVAL IS GIVEN BY THE QUALIFYING ACTIVITY. TEST SAMPLES SHALL NOT BE INCLUDED IN CONTRACT QUANITY.

Examples of Exceptions

NOTE: TESTING OF THE BATTERY SHALL BE IN ACCORDANCE WITH MIL-B-8565/10AS TABLE 1 WITH THE EXCEPTION OF THE FOLLOWING:

E. FIGURES 5: CHANGE THE VOLTAGE PROFILE TO REVISED PROFILE (FROM MOD OF PREVIOUS CONTRACT) HAVING DISCRETE STEPS OF 19.5V, 18.5V, 13V, AND 17.0V.

L. 3.6.8 CAPACITY AND ELECTRICAL PERFORMANCE: CHANGE -30C TO -26C.

N. 3.6.23 PROFILE DISCHARGE AT -18C: CHANGE FOR EACH PROFILE DISCHARGE TO TWO OF THE THREE PROFILE DISCHARGES.

T. 4.6.23 VIBRATION: DELETE THE TEXT OF E. AND SUBSTITUTE DURING VIBRATION, DISCHARGE THE BATTERY AT 3.5 AMPERES.

U. 4.6.23 VIBRATION: IN H. DELETE 3.6.11 AND SUBSTITUTE THE 14-VOLT DISCHARGE OF 4.6.11C.

Sustainment Engineering Reliability Projects

DLA can support you via the Reliability Initiative, to explore development efforts involving improving reliability or technology insertion.

Contact us: Sustainment Engineering Branch

- Dale Roberts, Navy Team, Engineer, at Dale.Robert@dla.mil or 804-279-3866
- Edilia Correa, Branch Chief, at Edilia.Correa@dla.mil or 804-279-6233

References

References:

John B. Timmons, PE and E. F. Koss, *Operational Testing of Valve Regulated Lead Acid Batteries in Commercial Aircraft*. (Concorde Battery Corporation). www.concordebattery.com/products/technical_info.

Using & Charging Ni-cad Batteries, Electus Distribution Reference Data Sheet: NICADS.PDF (1) (Electus Distribution, 2001). www1.electusdistribution.com.au/notes.asp.

Choosing A Rechargeable Battery, Electus Distribution Reference Data Sheet: RECHARGE.PDF (1) (Electus Distribution, 2001). www1.electusdistribution.com.au/notes.asp